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More frequent publication as acceptable material is contributed.

Dr. Frederick A. G. Muir

The late Dr. Frederick A. G. Muir of the Hawaiian Sugar Planters' Experiment Station was one of the first officers of the Pan-Pacific Research Institution and regularly attended the Friday evening science meetings during his residence in Hawaii. The members of this group offered a resolution at their May 22 meeting, which the Journal is publishing with a paper devoted to Dr. Muir's work prepared by two of his colleagues.

IN MEMORY OF DR. FREDERICK A. G. MUIR

It is with profound regret that we learn of the death in England, on May 13, 1931, of Dr. Frederick A. G. Muir, of the Hawaiian Sugar Planters' Association Experiment Station, who was chairman of the Science Council during the early years of the Pan-Pacific Research Institution. With his passing, science has lost one of her outstanding pioneer entomologists, and Hawaii has lost a naturalist, philosopher and friend.

His enthusiastic participation in round-table discussions at Friday evening suppers and his ready expression of firm convictions added much to the lively interest of these occasions.

A keen student of the great problems of the distribution and evolution of life in the Pacific, he did much to interpret these through his studies of native insect faunas, in some groups of which he was an acknowledged world authority.

He proved the practical value of his belief in the importance of biological control of insect pests by years devoted to the discovery and introduction of the natural enemies of the major insect pests of sugar cane in Hawaii. This was done to the detriment of personal comfort and health, but resulted in the saving of millions to the leading industry of these islands. In 1928, in recognition of these many achievements, the University of Hawaii conferred upon him the honorary degree of Doctor of Science, the highest title which it could bestow.

The Pan-Pacific Research Institute hereby records its esteem and high appreciation of Dr. Muir, and expresses its deep sympathy to the bereaved family.

O. H. Swezey,
E. H. Bryan, Jr.,

Committee, Pan-Pacific Research Institution.
May 22, 1931.

THE WORK OF DR. FREDERICK A. G. MUIR IN THE BIOLOGICAL CONTROL OF SUGAR CANE INSECTS IN HAWAII

By O. H. Swezey and F. X. Williams
of the Hawaiian Sugar Planters' Experiment Station.

With the death of Dr. Muir in England on May 13, 1931, ended the career of a man who had devoted his best years to the field of biological control as a method of controlling insect pests. Dr. Muir began this work for the Experiment Station of the Hawaiian Sugar Planters' Association in September, 1905. This was when the sugar cane leafhopper (*Perkinsiella saccharicida* Kirk.) was still a serious pest in Hawaii. It was also shortly after the introduction of the leafhopper egg-parasites * by Albert Koebele and Dr. R. C. L. Perkins, from Australia and Fiji. These parasites had not yet shown their ability to cope with the enormous numbers of their host. Mr. Koebele had been work-

* *Paranagrus optabilis* Perk., *P. perforator* Perk., and *Anagrus frequens* Perk., from Australia in 1904; and *Ootetrastichus beatus* Perk., from Fiji in 1905.

ing for more than ten years on the introduction of beneficial insects into Hawaii, and, being in failing health, wished to retire from active foreign work in the tropics. On his return from Fiji he spent but a short time in Honolulu in the summer of 1905, before leaving for California. Mr. Koebele never came to Honolulu again.

To carry on the work in which Mr. Koebele had been so successful since his arrival in Hawaii in 1893, Dr. Muir was engaged and his services on the staff of the Experiment Station, H. S. P. A., commenced September 1, 1905.

Spending but a short time in Honolulu, Dr. Muir's first foreign trip was to Fiji with the primary object of investigating the economic conditions of the leafhopper in cane fields there. This leafhopper was a different species from the cane leafhopper in Hawaii and was found doing no damage to cane, being kept in check by several natural enemies, the most important of which were the egg-parasites mentioned above and which had already been introduced into Hawaii. Another parasite found to have economic value was a stylopid (*Elenchus tenuicornis* Perk.). Attempts were made to introduce this parasite into Hawaii, but it failed to attack the leafhopper in the cane fields there. Still another parasite found was a dryinid (*Haplogonatopus vitiensis* Perk.), which was successfully introduced into Hawaiian cane fields, and for a time was quite a factor in the control of the leafhopper. After a number of years, however, it became scarce and in recent years has been seldom seen.

On this trip a great deal of time was spent in investigating the cane borer (*Rhabdocnemis obscura* [Boisd.]) to discover if possible the cause of its decrease there, for Mr. Koebele had reported such a decrease in Fiji since his visit there in 1892. No natural enemies were found that could be considered responsible for this. Some of the planters believed that the introduction of a harder variety of cane was the chief reason for the decrease of the borer. After six months in Fiji, Dr. Muir returned to Honolulu, where a few months were spent prior to starting off in July, 1906, for the Orient, where cane leafhopper parasites were investigated in south China in the vicinity of Macao, and inland from Canton. Cane leafhoppers there were found well controlled by egg-parasites similar to those in Australia and Fiji, and there were other valuable enemies as well. Only one of these was successfully introduced into Hawaii. This was a large black dryinid (*Pseudogonatopus hospes* Perk.), parasitic on adult leafhoppers. It was reared at the Experiment Station and colonies were distributed to the other islands, but it was only after nine years that it was known to have become established in Hawaiian cane fields. It never became very numerous, but even in recent years with the leafhopper usually scarce, this parasite maintains its existence, and an occasional parasitized leafhopper is to be found usually wherever any leafhoppers occur.

In February a brief visit was made to the Federated Malay States, where conditions as regards leafhoppers and their enemies were found to be about as in China. A search was begun for the cane borer beetle, which was continued in Java. Dr. Muir arrived at Batavia on March 10th and spent several months in the different sugar cane sections of Java, without finding any evidence of our cane borer beetle, or any direct parasites on related beetles in banana and palm trees.

On July 21 he left Java for a few weeks' search for the borer in Borneo, returning to Batavia in September, from which place another start was made in October, 1907. The search for the natural home of the beetle borer was continued in Amboina and Larat, where at last this insect was found in sago and pinang palms and in sugar cane. No success was had in finding parasites for several months, however. Finally, in January, 1908, a tachinid fly was found at-

tacking the grubs or larvae of this borer. Eight months were then spent at Amboina in studying this parasite and breeding it for shipment to Honolulu; but as the parasite could not survive such a long journey, attempts were made to establish a relay station at Hongkong. This station, which was to have been conducted by F. W. Terry, was not successful, as the tachinids always died en route. Finally Dr. Muir tried taking living material with him to Hongkong, but the flies all died the day before his arrival. This venture having failed, Dr. Muir left Hongkong in November, 1908, for further explorations, visiting Ceram and Makassar, en route to New Guinea, where he landed at Port Moresby in April, 1909. Here for the first time the tachinid parasite that was breeding so well on the borer grubs in palm trees at Amboina was found attacking a high percentage of the borer grubs in sugar cane. At once preparations were made for stocking cages with borer-infested cane in which the borers were to be parasitized, and then to bring them to Honolulu. Several months were required for this, and when eventually the cages were in readiness for the long journey, Dr. Muir fell ill with typhoid fever just prior to leaving Port Moresby, New Guinea, so that on arriving at Brisbane, Queenland, he was compelled to go to a hospital, where he remained for five weeks. His cages were forwarded to Honolulu, arriving there September 15, 1909. Over 200 of the tachinid flies had matured en route, but lacking the personal care that had been planned for them, all had died before their arrival in Honolulu. Thus is recorded another failure in the introduction of this parasite.

As soon as he had recovered sufficiently in the Brisbane hospital, Dr. Muir came on to Honolulu for further recuperation, arriving about the end of October, after an absence from Honolulu of three years and three months, most of which time was spent in tropical jungles, where he was exposed to the dangers of wild animals, venomous snakes and insects, as well as tropical diseases prevalent in those regions.

At once plans were made for further attempts to introduce this parasite on the cane borer. Dr. Muir left Honolulu January 8, 1910, on the final endeavor, which resulted in the transportation of the living parasite to Honolulu and its establishment in the cane fields of Hawaii. The procedure this time was the establishing of a relay breeding station at Mossman, Queensland, cared for by Mr. J. C. Kershaw. In cages here the tachinid was bred from material brought by Dr. Muir from New Guinea. Of the first generation of parasites reared in these cages, a portion was taken in the puparium stage to Fiji, where at Nausori another relay breeding station was established. From the next generation of parasites produced here, living material was brought to Honolulu by Dr. Muir on August 16, 1910. Mr. Kershaw arrived a month later with more material reared in Fiji. From both of these lots there were sufficient adult parasites to allow some to be liberated in a few cane fields, while others were retained for breeding in cages. Altogether, over four years were occupied on this project; from the beginning until living parasites were landed in Honolulu. The results obtained in checking the cane borer after the parasite was established and fully distributed more than justified the time, effort and expense involved.

Staying a short time, until the breeding of the tachinid was well started, Dr. Muir sailed from Honolulu October 4, 1910, for a well-earned leave, going to England for a year, and returning to Honolulu October 11, 1911.

The next large project undertaken by Dr. Muir was the endeavor to find and introduce natural enemies of the cane root grub, *Anomala orientalis* (Waterhouse), which in 1912 was found established in cane fields in the Pearl Harbor district of Oahu. There was little or no encouragement to be had from previous

efforts to control root grubs by natural enemies in other parts of the world. However, after duly considering the situation, Dr. Muir believed that an attempt should be made to control the spread of Anomala in our cane fields by this method. He left Honolulu for Japan March 28, 1913, that country being the home of *Anomala orientalis*. A number of valuable natural enemies were found working on Anomala there and efforts were made to introduce some of them here, but none ever became established. After about a year in Japan, search was made in Java, Formosa and the Philippines for parasites of closely related species of root grubs that might possibly be utilized against Anomala. The breaking out of the World War disturbed transportation from those regions, and it was found that the Philippines was the most favorable place in which to work and to secure dependable transportation for consignments of parasites. A large number of root-grub enemies were studied in the Philippines, headquarters being established at the College of Agriculture at Los Baños, where every facility for the work was rendered. Dr. Muir was assisted in the work here by Mr. H. T. Osborn and Dr. F. X. Williams, and large quantities of some of the parasites were reared for shipment to Honolulu, and many consignments were made during 1915, 1916 and 1917.

Of the numerous parasites of several kinds that were handled, *Scolia manilae* Ashmead, the wasp which parasitizes the Anomala grub, was the only one to become established in our cane fields. It was first found established and breeding on Anomala grubs September 16, 1916. In the four years since its discovery, Anomala had spread over a considerable area of cane land adjacent to Pearl Harbor. As soon as Scolia was found established in one field, assistance was given it in spreading throughout the Anomala-infested area. This was accomplished during the next year, and the wasp proved so efficient that attempts to introduce additional parasites on Anomala were discontinued. This project turned out to be the first successful control of a root grub by means of natural enemies.

During the four years involved in this work, Dr. Muir returned to Honolulu once or twice; on one trip, coming via Formosa, he brought some leafhopper egg-parasites, one of which (*Ootetrastichus formosanus* Timberlake) became established and spread throughout the cane fields of the islands and was an additional factor in the control of the sugar cane leafhopper. It persists to the present time, even where the leafhopper is normally scarce.

On October 31, 1917, Dr. Muir left for England to engage in war service for his native country in the trying days of the World War. He returned to Honolulu a year later, on October 28, 1918. In the meantime, he had married Margaret Annie Sharp on April 9, 1918, the daughter of Dr. David Sharp, the noted entomologist, who contributed much to the study of Hawaiian insects and to the Fauna Hawaiiensis. Mrs. Muir accompanied Dr. Muir on his return from England, and also on his last trip in search of parasites to Australia, which was begun early the next year.

Although there now existed a fairly satisfactory control of the sugar cane leafhopper by the introduced parasites previously mentioned, nevertheless in a few plantations there were recurrences of leafhopper outbreaks which were of considerable importance. The purpose of Dr. Muir's last trip, May 18, 1919, to June 21, 1920, was to endeavor to find what additional factors controlled the leafhopper in the Queensland cane fields. After considerable research he found that a small bug (*Cyrtorhinus mundulus* Breddin), of the family Miridae, lived by sucking the contents of the eggs of the leafhopper. The introduction of this bug into Hawaii was soon accomplished, chiefly from Fiji (where it was known to

occur) by Mr. C. E. Pemberton, the following year, September to November, 1920. This bug was reared and colonies distributed for a year, and from thereafter when it became thoroughly established, the control of the leafhopper pest in Hawaiian cane fields was practically complete. There have been slight outbreaks occasionally, but the Cyrtorhinus bug was always prompt to find them, and would soon increase to numbers sufficient to regain control. It has been thought that if this bug had been the only leafhopper enemy introduced it might of itself have been able to sufficiently control the leafhopper.

The total results of the major introductions above enumerated have been the saving of millions of dollars to the sugar industry in Hawaii, and the comparative freedom from destructive insect pests in the cane fields.

After returning from the last trip to Australia, Dr. Muir established his home in Honolulu. Much of his time was now devoted to systematic studies in Homoptera, particularly in Fulgoroidea. This is the group which contains the family Delphacidae, to which the cane leafhopper belongs. In his travels Dr. Muir made a specialty of studying and collecting sugar cane leafhoppers as well as other related leafhoppers. Many species of these were named and described by him in numerous papers included in the bibliography which follows. He became intensely interested also in the leafhoppers of the forests of Hawaii, and added many species to those already known, these new species of the Hawaiian fauna being published in the Proceedings of the Hawaiian Entomological Society. Dr. Muir eventually devoted himself to the study of leafhoppers the world over, and was recognized as a world authority on the leafhoppers of the family Delphacidae. Just before his death he was planning to work up a large collection from South America.

Dr. Muir's health had been undermined by so much time spent in unhealthful tropical jungles, etc., and he went to England at intervals, spending most of the years 1927 and 1928 there. On his return from England, September 12, 1928, arrangements were made for his retirement from active service at the Experiment Station, H. S. P. A. He left Honolulu on November 17, 1928, to make his home in England, and had made preparations for carrying on systematic work there in his favorite family of leafhoppers, which work, however, he was not able to pursue because of his failing health.

PUBLISHED WRITINGS OF DR. F. A. G. MUIR

In the Hawaiian Planters' Monthly and Hawaiian Planters' Record

1908. Report of travels in Borneo in search of cane borer parasites. Planters' Monthly, XXVII, pp. 50-57.

1908. Report on the search for the sugar cane borer in the Malay Archipelago. XXVII, pp. 252-257.

1909. Report on the sugar cane borer in the Moluccas. Planters' Record, I, pp. 40-48, 1 map.

1909. Concluding report on travels in the Malay Archipelago in search of parasites for the cane borer. I, pp. 256-261.

1910. Report on second trip to British New Guinea to obtain a tachinid fly, parasitic on the sugar cane beetle borer. III, pp. 186-200, 5 plates.

1914. Observations in Formosa. I, pp. 274-281.

1915. The relation of the parasite to its host. XIII, pp. 118-125, 1 diagram.

1917. Remarks on leafhopper outbreaks. XVII, pp. 227-230.

1919. The use of insecticides against leafhoppers. XX, pp. 171-172.

1919. Leafhopper infestation in plant cane. XX, pp. 380-381.

1920. Report of entomological work in Australia, 1919-1920. XXIII, pp. 125-130, 1 Figure.

1920. The "Japanese" beetle is Chinese. XXIII, p. 291.

1921. Cyrtorhinus in Hawaii and some factors acting against it. XXIV, pp. 285-286.

1921. The fern weevil in Australia. XXV, pp. 2-3.

1922. Direct and indirect injury to plants by insects. XXVI, pp. 65-66.

1922. Earthworms and their culture in relation to agriculture. XXVI, pp. 159-163.

1931. The biological control of the coconut moth (*Levuana iridescens* Beth-Baker) in Fiji. XXXV, pp. 85-87.

CO-AUTHORSHIP

Muir, F., and Henderson, G. 1926. Nematodes in connection with sugar cane root rot in the Hawaiian Islands. XXX, pp. 233-250, 14 Figures.

Muir, F., Henderson, G., and Zwaluwenburg, R. H. 1927. A generic list of the spear-bearing nematodes with a revised dichotomous table. XXXI, pp. 354-361.

Muir, F., and Swezey, O. H. 1926. Entomologists' Report on Termite Problem. XXX, pp. 331-335.

Muir, F., and Van Zwaluwenburg, R. H. 1927. The bad effect of leaf pruning upon the growth of stalk and root of sugar cane. XXXI, pp. 110-112, 2 figures.

Stewart, G., Muir, F., Van Zwaluwenburg, R. H., Cassidy, G. H., and Hansson, F. 1928. The relation between soil treatments and nematode attacks to cane roots in central Maui soils. XXXII, pp. 205-217.

As Bulletins or Circulars of the Experiment Station, Department of Entomology, Hawaiian Sugar Planters' Association.

1906. Notes on Some Fijian Insects. Bull. 2, pp. 1-11, 1 plate.

1907. Report on Investigations in South China. Circular No. 1, pp. 1-11.

1907. Notes on the Sugar Cane Hoppers and Borers in the Malay States and Java. Circular No. 2, pp. 1-13.

1908. Entomological Work in Borneo. Circular No. 4, pp. 1-12.

1910. On Some New Species of Leafhopper (*Perkinsiella*) on Sugar Cane. Bull. No. 9, pp. 1-11, 5 figures.

1926. Contributions to Our Knowledge of South American Fulgoroidea (*Homoptera*), Part I, The Family Delphacidae. Bull. 18, 51 pp., 5 plates.

1931. The Insects and Other Invertebrates that Occur in Hawaiian Sugar Cane Fields. Introduction. pp. 11-32.

CO-AUTHORSHIP

Kirkaldy, G. W., and Muir, F. 1913. On Some New Species of Leafhoppers. (Part I *Cicadidae, Cercopidae* and *Fulgoridae* by Kirkaldy; Part II, *Derbidae* by Muir. Bull. No. 12, pp. 28-92, 3 plates.

Muir, F., and Swezey, O. H. 1916. The Cane Borer Beetle in Hawaii and its Control by Natural Enemies. Bull. 13, pp. 1- 51, 4 figures and 4 plates.

Muir, F., and Giffard, W. M. 1924. Studies in North American Delphacidae. Bull. 15, 53 pp., 6 plates.

In the Proceedings of the Hawaiian Entomological Society

1908. On the stridulating organ of a sphingid from Larat. II, pp. 12-13.

1913. On an abnormal larva of *Lasiorhynchus barbicornis* (Fabr.). II, pp. 219-220.

1913. On some new Fulgoroidea. II, pp. 237-269, 6 plates.

1914. On some Derbidae from Formosa and Japan. III, pp. 42-52.

1914. Presidential address. III, pp. 28-42, 1 diagram.

1914. A Delphacid on bamboo in Formosa. III, p. 53.

1915. New and little known Derbidae. III, pp. 116-136, 3 plates.

1916. Review of the autochthonous genera of Hawaiian Delphacidae. III, pp. 168-221. Part II biogenetic, pp. 197-221, 79 figures.

1917. New Hawaiian Delphacidae. III, pp. 298-311, 1 plate.

1917. Homopterous notes. III, pp. 311-338, 2 plates.

1918. Two new species of *Nesosydne*. III, pp. 405-407.

1918. Homopterous notes, II, Vol. III, pp. 414-428.

1919. New Hawaiian Delphacidae. IV, pp. 84-108, plates III and IV, 4 figures.

1919. On the genus *Ilburnia* White (Homoptera, Delphacidae). IV, pp. 48-50.

1921. On some Delphacidae from South India (Homoptera). IV., pp. 480-486, 2 figures.

1921. New Hawaiian Delphacidae (Homoptera). IV, pp. 507-520, 1 plate.

1921. On some Samoan Fulgorids (Homoptera). IV, pp. 564-584, 1 plate.

1922. A new Hawaiian Delphacid (Homoptera). V, pp. 87-88, 2 figures.

1922. An interesting new Derbid genus (Homoptera). V, pp. 89-90, 5 figures.

1922. New and little known Hawaiian Delphacidae (Homoptera). V, pp. 91-102, 1 plate.

1923. On the classification of the Fulgoroidea (Homoptera). V, pp. 205-247, 5 plates.

1924. New and little known Fulgoids from the West Indies (Homoptera). V, pp. 461-472, 1 plate.

1924. Homoplasmy or Convergent Development in Evolution (Presidential address). V, pp. 473-483.

1925. On the Status of the Anterior Processes of the Male Genitalia in Homoptera. VI, pp. 41-45.

1926. Some Remarks on Dr. Hem-Singh Pruthi's Paper on the Morphology of the Male Genitalia in Rhynchota. VI, pp. 323-334, 1 plate.

1926. *Atopocixius,* a New Genus of Uncertain Position in the Fulgoroidea (Hom.). VI, pp. 335-336, 1 plate.
1928. Some remarks on function as a base for classification and its relationship to form. VII, pp. 135-145.
1929. Parallelisms between the Insect Fauna of Hawaii and that of Samoa. VII, pp. 259-260.
1931. New and little-known Fulgoroidea from South America (Hom.) VII, pp. 469-479, 1 plate.

Published Outside the Territory of Hawaii

1907. Notes on the stridulating organ and stink glands of *Tessaratoma papillosa.* Trans. Ent. Soc. London, pp. 256-258, 3 figures.
1909. Notes on the life-history of *Aulacodes simplicialis* Snell. Proc. Ent. Soc. London, XL-VLIV, 4 figures. (A letter to Prof. Poulton).
1912. Two new species of *Ascodipteron.* Bull. Mus. Comp. Zool. Harvard Coll. 54, pp. 349-366, plates I-III.
1913. On the genus *Lamenia* Stål. Can. Ent., 45, p. 112.
1914. On the original habitat of *Stomoxys calcitrans.* Jour. Econ. Ent. 7, pp. 459-460.
1915. Notes on the ontogeny of the genital tubes in *Coleoptera.* Psyche, 22, pp. 147-152, plate XII.
1915. A contribution towards the taxonomy of the Delphacidae. Can. Ent. 47, pp. 208-212, etc.
1916. A new Formosan *Purohita* (Delphacidae). Philip. Jour. Sci., 11-D, p. 311.
1916. Additions to the known Philippine Delphacidae. Philip. Jour. Sci., 11-D, pp. 369-385.
1917. The Derbidae of the Philippine Islands. Philip. Jour. Sci., 12-D, pp. 49-104, plate.
1917. A new genus of Derbidae from Borneo. Philip. Jour. Sci., 12-D, pp. 217-218.
1917. A new Philippine genus of Delphacidae. Philip. Jour. Sci., 12-D, pp. 217-218.
1917. The introduction of *Scolia manilae* Ashm. into the Hawaiian Islands. Ann. Ent. Soc. Amer. 10, pp. 206-210.
1918. Notes on the otogeny and morphology of the male genital tube in *Coleoptera.* Trans. Ent. Soc. London, pp. 223-229, plate X.
1918. Pipunculidae and Stylopidae in *Homoptera.* Ent. Mo. Mag. 54, p. 137.
1918. Notes on the Derbidae in the British Museum. Ent. Mo. Mag. 54, pp. 173-177, 202-207.
1918. Notes on the Derbidae in the British Museum Collection II, Derbinae. Ent. Mo. Mag. 54, pp. 228-243.
1919. Some Malayan *Delphacidae* (Homoptera). Philip. Jour. Sci., 15, pp. 521-531, 1 plate.
1919. Notes on the Delphacidae in the British Museum Collection. Can. Ent., 51, pp. 6-8.
1919. Some new American Delphacidae. Can. Ent., 51, pp. 35-38.
1920. A new genus of Australian Delphacidae. Proc. Linn. Soc. N. S. Wales, 45, pp. 181-182.
1920. The male abdominal segments and aedeagus of *Habrocerus capillaricornis* Grav. *Coleoptera,* Staphylinidae, Tr. Ent. Soc. London, 1919-1920, pp. 398-403, plate XX.
1920. On the mechanism of the male genital tube in *Coleoptera.* Tr. Ent. Soc. London, 1919-1920, pp. 404-414, plate XXI.
1920. On some African Delphacidae (Homoptera). Bull. Ent. Res., 10, pp. 139-144.
1921. A symbiotic organism in Fulgorids. Psyche, 28, pp. 59-60.
1921. On some recent remarks on the phylogeny of *Homoptera.* Psyche, 28, pp. 116-119.
1921. The male genitalia of *Merope tuber* Newm. (*Mecoptera*). Tr. Ent. Soc. London, pp. 231-232, 1 plate.
1922. On some Indian Derbidae (*Homoptera*). Rec. Ind. Mus. Calcutta, 24, pp. 335-342, 8 figures.
1922. New Indian *Homoptera.* Rec. Ind. Mus. Calcutta, 24, pp. 343-355, 4 figures.
1922. New Malayan Cixiidae (*Homoptera*). Philip. Jour. Sci. 20, pp. 111-120, 2 plates.
1922. Three new species of Derbidae (*Homoptera*). Philip. Jour Sci., 20, pp. 347-349, 4 figures.
1922. A new genus of Australian Cixiidae (*Homoptera*). Proc. Linn. Soc. N. S. W., 47, pp. 63-64.
1922. On the genus *Elidiptera* Spin (Homoptera). Can. Ent. 54, p. 61, 2 figures.
1923. On the homology between the genitalia of some species of Diptera and those of *Merope tuber.* Trans. Ent. Soc. London, pp. 176-180, 2 plates.
1923. New species of Fulgorids (Homoptera). Ann. Mag. Nat. His. (9) 11, pp. 553-560.
1923. On the characters separating Heteroptera from Homoptera. Ent. Mo. Mag. 59, p. 254.
1923. Two species of Delphacidae (Homoptera) from Kermadec Archipelago. Trans. N. Z. Inst. 54, p. 257.
1923. New species of New Zealand Delphacidae (*Homoptera*). Trans. N. Z. Inst. 54, pp. 258-259, 4 figures.

1923. A new species of *Derbe* Fabr. (*Homoptera*) Notulae Ent. Helsingfors, 3, p. 67.
1923. A new Philippine *Stenocranus* (Delphacidae Homoptera). Philip. Jour. Sci. 22, pp. 157-159, 2 figures.
1923. The genus *Myndus* in the Malay States (Homoptera). Philip. Jour. Sci. 22, pp. 161-170, 1 plate.
1923. Two collections of Fulgoroidea from Sumatra. Philip. Jour. Sci. 22, pp. 171-178, 1 plate.
1923. *Achilixius,* a new genus constituting a new family of the Fulgoroidea (Homoptera). Philip. Jour. Sci. 22, pp. 483-487, 1 plate.
1924. An American Tettigometrid (Homoptera). Ann. Ent. Soc. Amer. 17, pp. 210-222, 6 figures.
1924. Notes on some genera of Derbidae (Homopt.). Proc. Ent. Soc. Wash. 26, pp. 15-19.
1924. A new genus of the family Achilixiidae (Homoptera). Can. Ent. 56, pp. 33-34, 1 figure.
1924. New Malayan species of *Oliarus* Stål. (Cixiidae, Homoptera). Philip. Jour. Sci. 24, pp. 509-527, 2 plates.
1924. On some new and little known Australian Fulgoroidea (Homoptera). Mem. Queensland Mus. 8, pp. 29-36, 6 figures.
1924. On a new Cixiid attacking coconut palms (Homoptera). Bull. Ent. Res. 14, p. 456, 1 figure.
1925. The male genitalia of *Cupes concolor* Westw. (Coleoptera). Jour. New York Ent. Soc. 32, pp. 167-169, 1 plate.
1925. On the genera of Cixiidae, Meenoplidae and Kinnaridae (Fulgoroidea, Homoptera). Pan-Pacific Ent. 1, pp. 97-110, 156-163.
1925. On the genera *Amblycotis* Stål. and *Bostaera* Ball (Delphacidae, Homoptera). Can. Ent. 57, p. 279.
1925. *Parandes,* a new Cixiid genus (Homoptera, Fulgoroidea). Philip. Jour. Sci. 26, pp. 511-512, 2 figures.
1925. The genus *Andes* Stål. (Cixiidae, Homoptera). Philip. Jour. Sci. 27, pp. 201-226, 2 plates.
1925. A new species of *Oliarus* from China (Fulgoroidea, Homoptera). Philip. Jour. Sci. 28, pp. 365-366, 1 figure.
1925. On some Fulgorids (Hemiptera-Homoptera) from the Island of Rodrigues. Trans. Ent. Soc. London, 1924-1925, pp. 463-474, 2 plates.
1925. Two new species of exotic Delphacidae (Homoptera). Ent. Mo. Mag. 61, pp. 221-222, 1 figure.
1926. Reconsideration of some points in the morphology of the head of Homoptera. Ann. Ent. Soc. Amer. 19, pp. 67-73, 1 figure.
1926. On some new and little-known Delphacidae from South Africa (Fulgoroidea, Homoptera). Ann. Mag. Nat. Hist. (9), 17, pp. 17-35, 37 figures.
1926. Notes on some African Derbidae (Homoptera). Ann. Mag. Nat. Hist. (9), 18, pp. 227-240, 18 figures.
1926. The morphology of the aedaegus in Delphacidae (Homoptera). Trans. Ent. Soc. London 74, pp. 377-380, 2 plates.
1927. Insects of Samoa. Fulgoroidea. 2, Hemiptera, London, Br. Mus. (Nat. Hist.), pp. 1-27, 25 figures.
1927. New species of African Meenoplidae (Fulgoroidea, Homoptera). Ann. Mag. Nat. Hist. (9), 19, pp. 197-208, 20 figures.
1927. On some Fulgorids from the South Pacific. Ann. Mag. Nat. Hist. (9), 20, pp. 86-91, 7 figures.
1927. Remarks on the morphology of the male genitalia in Lepidoptera. Ent. Mo. Mag. 63, pp. 172-174.
1928. Notes on some African Derbidae (Homoptera). II, Ann. Mag. Nat. Hist. (10), 1, pp. 498-525, 38 figures.
1928. Spolia Mentawiensia, Fulgoroidea, Homoptera (Cixiidae, Meenoplidae, Delphacidae, Derbidae). Jour. Malayan Brit. Asiat. Soc. 4, pp. 392-409, 34 figures.
1928. The evidence for hybrid vigour in insects. Nature, 121, p. 56.
1929. New and little-known South American Delphacidae (Homoptera, Fulgoroidea) in the collection of the British Museum. Ann. Mag. Nat. Hist. (10), 3, pp. 75-85, 22 figures.
1929. New and little-known African Delphacidae (Homoptera, Fulgoroidea) in the collection of the British Museum. Ann. Mag. Nat. Hist. (10), 4, pp. 186-222, 57 figures.
1929. The tentorium of Hemiptera considered from the point of view of the recent work of Snodgrass. Ent. Mo. Mag. 65, pp. 86-88.
1929. The role of function in Taxonomy and its relationship to the genitalia of insects. Trans. 4th Internat. Congress Ent. Ithaca, Aug., 1928, Tring Herts 2, pp. 600-604.
1930. Three new species of American Cixiidae. Pan-Pacific Ent. 7, pp. 12-14, 4 figures.
1930. IV, new Derbidae from Sierra Leone (Homoptera, Fulgoroidea). Ann. Mag. Nat. Hist. (10), 5, pp. 81-84, 8 figures.
1930. Notes on certain points of morphology of the abdomen and genitalia of Psyllidae. Ann. Mag. Nat. Hist. (10), 5, pp. 545-552, 4 figures.

1931. New and little-known Fulforoidea in the British Museum. Ann. Mag. Nat. Hist. (10), 7, pp. 297-314, 11 figures.

CO-AUTHORSHIP

Muir, F., and Sharp, D. 1904. On the egg-cases and early stages of some Cassididae. Trans. Ent. Soc. London, pp. 1-24, plates I-V (Coleoptera). 1912. The comparative anatomy of the male genital tube in *Coleoptera.* Trans. Ent. Soc. London, pp. 477-642, plates XLII-LXXVIII.

Muir, F., and Kershaw, J. C. 1911. On the homologies and mechanism of the mouth-parts of Hemiptera. Psyche, 18, pp. 1-12, 5 plates.

Muir, F., and Kershaw, J. C. 1911. On the later embryological stages of the head of *Pristhesancus papuensis* (Reduviidae). Psyche, 18, pp. 75-79, plates IX and X (Heteroptera).

Muir, F., and Kershaw, J. C. 1912. The development of the mouth-parts in the Homoptera, with observations on the embryo of *Siphanta.* Psyche, 19, pp. 77-89, 14 figures.

Kershaw, J. C., and Muir, F. 1907. On the egg-cases and early stages of some south China Cassididae. Trans. Ent. Soc. London, pp. 249-252.

Kershaw, J. C., and Muir, F. 1922. The genitalia of the Auchenorhynchous Homoptera. Ann. Ent. Soc. Amer. 15, pp. 201-212, 1 plate.

The Royal Hawaiian Hotel Gardens

By PETER T. BARNHART

(In the Honolulu Advertiser)

The crowning glory in the way of gardens that ever has come under my observation is the 20-acre garden of the Royal Hawaiian Hotel, Honolulu. The best of all the gardens and conservatories I have visited are poor in comparison. It is like unto a sea of green, on the surface of which float islands of tropical vegetation, the shores being bordered with foliage plants, rich in color, diverse in form, and luxuriant beyond anything one can imagine in plant life.

Now let us get down to details of the multitudinous subjects growing therein. First about the plants in the borders. Fancy-leaved caladiums of gorgeous coloring; dracaenas, red, green and multi-colored; dieffenbachias, mingling their variegated foliage with native tree ferns (*Cibotium glaucum*, which are just tall enough to show their beautiful smooth foliage; *Caladium esculentum;* xanthosoma; alocasias—and if you want to see luxuriant growth of these tropical plants, go to the garden I am talking about; the variegation in the foliage of some of the species is beyond compare. It must be kept in mind that all these plants are natives of tropical jungles where they are protected from the glare of a tropical sun. In this instance a grove of coconut palms towers above, the interlacing fronds affording the necessary shade.

One day, while walking through a section of this amazing garden, I saw a movement of the foliage; supposing it to be caused by a dog or some other animal, I parted the foliage and, to my surprise, there was a man wiggling his way through it, collecting every leaf that was on the decline and had a tendency to mar the beauty of the border.

Outside the border of tropical foliage, yet beneath the shelter of the palms, grew a single specimen of *Pritchardia pacifica,* a palm from the Fiji Islands. It is about five feet high and of all palms ever I have seen it is the most beautiful. The foliage is perfect in outline, and beneath, it is covered with a white tomentum, as are the petioles.

Now let us look at the plants of one of the aforementioned islands on that sea of green. On one is a group of Chamaedorea, a cespitose species. For a border *Allamanda hendersoni* is used, kept down by judicious pruning. Sprinkled among all shrubbery of all the islands are plants of Madagascar periwinkle (*Vinca rosea*). For a "base planting" (if you may use

the term for a bank of shrubbery and trees around a building) there are breadfruit trees (*Artocarpus incisa*), a species of the mulberry family, but less effective because of the fruit than for the large, lustrous pinnate foliage; *Spathodea campanulata* or African tulip tree, aptly named because the flowers are large, bright red, growing in clusters atop of the branches; *Catalpa longissima,* a broad-leaved evergreen with pure white flowers, but insofar as they are concerned, not as beautiful as our hardy species; and hibiscus. Oh, the hibiscus! Of every conceivable color, veritable bouquets are they. Then, too, oleanders are a prominent feature of the banks.

In that garden grows a species of aralia which I believe to be brassaiopsis. Johnson's is the only work at my command which makes mention of this very remarkable small tree. The flowers are red, followed by black fruits about as large as peas, which are sessile, and cling to the slender 2-feet long stems. The tentacles of the octopus are the only things I can liken them to. The foliage is digitate, composed of ten slender leaflets. The fish-tail palm (*Caryota urens*) with its weeping inflorescence, seems to survive the flowering function, whereas in conservatories here it dies, after the last flowers appear near the base of the tree.

And now about the care that has brought about the marvelous results in that garden. First there is the superintendent, a Scotsman named Angus MacGillvray. No matter what the facilities are for gardening, it is the skill of the man who directs the activities that produces results. Water he has in abundance and the sprinklers are going all the time. A ton of sulphate of ammonia is applied annually, and not a dead leaf or branch of tree or shrub may be seen on those grounds. He has all the help he wants, and the men all go barefoot.

Since my return I have been asked time and again: "Is it worth while to make the trip to those islands?" Emphatically I say, "Yes." The grounds of the big hotel are worth all the expense of the trip.

Hillebrand or Foster Park

(From the Honolulu Star-Bulletin)

A young German doctor with a quiet manner, gray eyes, heavy dark hair and a flair for botany came to the Sandwich Islands in 1851 seeking a climate to restore his shattered health.

Dr. William Hillebrand was a worker. In a few years he established a practice in Honolulu, acquired the post of physician at the Queen's hospital, learned the Hawaiian language, opened a drug store with J. Mott-Smith at Fort and Hotel streets, married Anna Post, and collected a great many specimens of Hawaiian flora.

Kamehameha V, who made Dr. Hillebrand his private physician and admitted him to the Privy Council, sent him, as Commissioner of the Bureau of Immigration in 1865 on a trip to China, India and the Malay Archipelago. The doctor was to arrange the importation of laborers for the cane fields, study the control of leprosy abroad, and secure whatever seeds, plants and animals he thought might be of use here.

On that trip the diligent scientist from Westphalia shipped back to Hawaii strange-looking boxes and crates from Singapore, Calcutta, Ceylon, Java and Hongkong. Through the Hillebrand importations, Hawaii acquired not only the monkeypod and the mynah, but also the royal palm, camphor, cinnamon, mandarin orange, Chinese plum, jack fruit, Java plum, lichee, several species of Eugenia and banyan and the following birds and animals:

Carrion crow of Calcutta, goldfinch,

Indian sparrow, Japanese finch, Chinese quail, Mongolian golden and silver pheasants, linnet, rice bird and a pair of deer each from China and Java.

The Royal Hawaiian Agricultural Society, of which Dr. Hillebrand was corresponding secretary, gave him $500 to buy these specimens of Asiatic flora and fauna. He planted most of them in the garden about his home on Nuuanu street, between School and Vineyard streets, where exotic trees and shrubs were soon growing in profusion.

In that five-acre garden were grown the parent plants from which sprang many fine specimens now scattered over the several islands. Dr. Hillebrand loved to work with his plants, trimming, training and nursing them. He was constantly jotting down notes for a book on the "Flora of the Hawaiian Islands" which his eldest son published posthumously.

In 1871, Dr. Hillebrand left the islands after selling his unique garden to Thomas R. Foster, a neighbor. The grounds came to be called the Foster Place. With the recent death of Mrs. Mary E. Foster, this property was bequeathed to the city and county to be used as a park with the name of Foster Park.

In a week or so the city is expected to take over this famous garden and transform it into the park which Mrs. Foster visioned. Some of the dense growth will have to be thinned out and many of the fine old trees will require the services of a tree surgeon.

The garden includes specimens of the earpod tree, kauri pine of New Zealand, many odd types of palms such as kahune nut, wine and bottle palms, strychnine tree, garcinia, mangosteen, bamboo, olive, breadfruit, sacred tree of India, several varieties of ginger, allspice and monkey-puzzle.

Wild parrots may be seen atop the palms.

The Culture of the Chinese Banana in Hawaii

By EDWARD Y. HOSAKA
University of Hawaii

Banana culture in Hawaii has increased steadily until today banana production ranks fourth in the agricultural industries of Hawaii. Many fertile lowlands in Hawaii are devoted to the cultivation of the Chinese banana, for this variety is well adapted to the local conditions, and produces splendid fruit.

This variety was first found in southern China, from there it found its way to all the tropical countries. According to Dr. William Hillebrand, the Chinese banana was introduced into the Hawaiian Islands from Tahiti about the year 1855. Soon after its introduction to Hawaii, this variety attracted much attention and the people began to cultivate it extensively. As a result, the number of bunches of banana shipped to California, where the demand is great, has increased from 93 bunches in 1856 to 216,733 bunches in 1927. This banana is also consumed locally, and is an important food.

The stem of the Chinese banana is thick and robust, but stands only five to seven feet high. The apparent stem is really made up of layers of leaf bases which have modified into a thick tissue for support and storage organs, hence it is not a true stem. Through this large leafy stem the plant is able to take up a large volume of water (in which is dissolved the mineral substance) to the large leaves where starch or the food of the plant is manufactured.

The leaves are comparatively broad and borne on short leaf-stalks. These large leaves are of great advantage to the plant because the greater the leaf area the more food can be manufactured. The leaves of the Chinese banana are normally about ten feet long and two feet wide. The

young leaves that come out upright from the top of the stem are cylindrically rolled and are closed at the tips before expanding. The blades or leaves are not divided like that of the coconut leaves, but are a flat undivided single sheet.

The cord-like roots of the Chinese banana are uniform in size and are about the diameter of a lead pencil. These roots, which give the plant good anchorage, spread horizontally in search of food and moisture.

The flowers are borne in large drooping clusters on fleshy stalks, and each cluster is protected by a colored leafy bract. As the ovaries begin to develop into fruit the bract falls off, exposing the cluster or hand of fruit, each hand having about fifteen to twenty individual fruits.

In the matter of propagation, the first thing to consider after the land is selected is shelter. Since the function of the leaves is to obtain from the atmosphere food for the growth of the plant, the leaves need the greatest protection possible from strong wind. The water absorbed by the roots, together with the mineral food in solution, is carried to the leaves and there with the carbon dioxide from the air, the various organic compounds are elaborated by the plants. The manufactured food is then transferred and used where required or is stored up in the bulb for future use.

The preparation of the land for banana planting requires deep cultivation, at least fifteen inches, to loosen up the ground for lateral root growth. After the land is plowed, irrigation furrows are cut, and then the holes are dug, large enough to receive the roots without bending them from their normal position, and deep enough so that when filled the plant will stand four to five inches deeper than when it was on the parent stalk. Fairly deep planting insures, in a measure at least, against the roots becoming exposed through the washing of the soil in irrigation and through the subsequent tillage of the orchard. If planted too shallow the sucker is easily shaken by the wind and the normal growth impeded. A sucker is the young shoot that sprouts out from the base of the mother plant. This shoot grows and takes the place of the mother plant, since the banana plant dies after producing one bunch of fruit.

Irrigation is the principal factor in the culture of banana, for the normal growth of the plant depends on water supply. The amount of water to be given to the plant depends on the nature of the soil; if the soil is rich in humus a little water is enough, but in light soil, unless the subsoil is of such a nature as to retain moisture, it is better to give plenty of water.

In Hawaii bananas ripen throughout the year. This is one reason why the fruit is an important food of the people. The fruit is cut when it is green because it ripens best when off the plant. The harvested bunch is washed, weighed and inspected before it is wrapped for shipment. It is first wrapped in a layer of soft paper, then in a padding of hay straw, with finally an outer covering of banana leaves.

The banana is an economical and satisfying article of diet in Hawaii because it is about the only fruit which is obtainable throughout the year. Because of these facts it is consumed alike by both the rich and the poor in Hawaii. It has high energy value when compared to other foods. One pound of banana produces 460 calories or heat factors that give warmth and energy to the body, whereas only 240 calories in oranges, 290 calories in apples and 145 calories in cabbage can be obtained from the same amount.

When the banana is compared to other food crops, it leads in production per acre. From an acre 32,000 pounds of bananas producing 8,320,000 calories can be harvested, while from an equivalent acreage only 1,620 pounds of wheat, 3,000 pounds of rice and 2,240 pounds of corn, producing 2,673,000 calories, 4,860,000 calories and 2,662,000 calories respectively can be obtained.

Pearl Culture in Hawaii

A Message from Alexander Hume Ford, Director of the Pan-Pacific Union, read before the Pan-Pacific Research Institution, April 6.

Tokyo, March 25, 1931.—Mr. K. Mikimoto is preparing for the Pan-Pacific Clubhouse a display of "culture pearls" and exhibits showing the method of planting and raising the pearl oysters and "cultivating" the gems. It is entirely possible that in Hawaiian waters pearl oysters may be made to bear pearls, many of them of high commercial value.

I have spent some days with Mr. Mikimoto, the inventor and patentee of the process of compelling oysters to manufacture pearls to order. He is deeply impressed with the idea of establishing pearl culture gardens in Hawaiian waters, and wishes the coöperation of the Pan-Pacific Research Institution and our Industrial Committee in this enterprise.

It may be said that the work done by our scientists is responsible for Mr. Mikimoto's conviction that the waters of Hawaii, especially those about the Island of Oahu, may be made to sustain profitable pearl culture farms.

Some years ago Dr. C. Ishikawa was brought as a guest to the Pan-Pacific Research Institution. He is one of Japan's outstanding ichthyologists and an authority on oysters and pearls. Ishikawa, Dr. David Starr Jordan, President of the Institution, Dr. Wakiya, head of the Korean Fisheries Bureau, Dr. Warren Barton Everman, and the late Allan McCulloch, noted Australian ichthyologist, spent some months together as guests at the Pan-Pacific Research Institution studying the fish of Hawaii. Wakiya and Ishikawa sought especially for places where the Japanese pearl oysters might grow. They were successful in finding such places. Later Dr. Paul Galtsoff met Mr. Mikimoto in Florida, seeking a place near Miami where a pearl culture station might be established, but so far pearl oysters have not grown in Southern Florida. So Dr. Galtsoff began to look to Hawaii as the location of a possible pearling station. He wrote to the Pan-Pacific Research Institution, and it was at once arranged that the chairman of our junior scientists, Northrup Castle, would accompany Dr. Galtsoff as guide to the pearl lagoons of Pearl and Hermes Reef (a thousand miles northwest of Hawaii), with which he was familiar. On his return, in an address to the members of the Institution, Galtsoff announced that pearl oysters could be grown in Hawaiian waters. A motion picture film describing the method of pearl culture in Japan was shown at the Science Council of the Pan-Pacific Union.

On my recent arrival in Japan, I got in touch with the experts in charge of pearl production. They were enthusiastic over the suggestion that the firm establish a pearl culture farm in Hawaii and at once telephoned to Mr. Mikimoto (The "Pearl King"), at Toba, some three hundred miles to the south. A quick and cordial invitation was extended to the Director of the Pan-Pacific Union to visit the pearl farms and confer with him. One of these men was a pupil of our Dr. Harada at Doshisha University.

I spent two days with Mr. Mikimoto visiting his culture farms and discussing with him (through an interpreter) the possibilities of pearl culture in Hawaii. I found that he, Dr. Galtsoff, and Dr. Wakiya had already talked this over and that the work of the Pan-Pacific Research Institution was quite familiar to him, its proceedings and publications being translated into Japanese for his benefit. I am to confer with him and Dr. Ishikawa in Tokyo at an early date.

I am asking in behalf of the Institution that Dr. Ishikawa, Dr. Galtsoff, and Gilbert Whitley, an ichthyologist of Australia, be guests this summer for some months at the Pan-Pacific Research In-

stitution, each bringing the spat of oysters from his country that he thinks may best thrive in Hawaiian waters. Mr. Mikimoto and I have gone over depth maps and charts of the coasts of all the Hawaiian Islands, discussing the most feasible sites for experimental culture work. I believe that the oysters sent by Dr. Ishikawa from Japan, while growing successfully, were unfortunately placed in a portion of Kaneohe Bay since buried over by drifting sand. I have suggested that the spat might be planted in some of our deserted fish ponds for the first three years until they are ready for the surgeon's knife and the insertion of the seed pearl. After that they will be put in wire cages and hung from great rafts in deep water. The channels in Pearl Harbor and Kaneohe Bay would be ideal, especially Kaneohe Bay, if by act of Legislature oil-burning vessels might be excluded.

In Japanese waters the oysters remain in their cages for seven years, for the full life of the pearl oyster is ten years, and the largest pearls are found in the oldest oysters. It is believed that the pearl coating process would go on the year round in Hawaiian waters, whereas in Japan the oysters, as Mr. Mikimoto puts it, sleep half the time and don't work. It may be that larger pearls in a shorter time may be produced in Hawaii. There would be no duty on these pearls sent to the Mainland, in fact the world would be their market.

Northrup Castle, Jr., will doubtless gladly aid in the experiments with pearl oysters—as to the length of time it takes for them to reach maturity in our warm waters and if they breed after maturity. Perhaps not, but Mr. Mikimoto tells me the spat by the millions or even the three-year-old oysters may be shipped annually to Hawaii and planted there for rapid growth in the warmer waters. The results of experiments along these lines with Mainland turtles and turtle eggs carried on by young Castle, are fully known and discussed here in Japan and Mr. Mikimoto is keenly interested. I think Dr. Ishikawa and a representative of Mr. Mikimoto may be expected to join our little group of scientists at the Institution this summer and a real start made toward introducing the culture pearl into Hawaiian waters.

Mr. Mikimoto is one of the most forceful and genial men I have ever met. He is 73 and as active as a man of fifty. He has been made a member of the House of Peers and is one of Japan's big men. He began life, he tells me, as a macaroni manufacturer in a very small way. I append herewith a brief history of his march toward becoming the pearl king that he is. While with Mr. Mikimoto at his culture bays, I made more than a hundred pictures, which I hope to throw on the screen during a meeting of the Pan-Pacific Research Institution workers—this, with the exhibit Mr. Mikimoto is preparing for us, should give a fair idea of pearl culture in Japan and what we may expect for Hawaii. I trust that your Institution and the Industrial Committee of the Pan-Pacific Club will guide the plans through to success.

"In Japan pearls must have been found very early, for a passage in the ancient historical record, 'Kojiki,' tells how much they were treasured then. Shima has been the center of pearl fishery for years, but as articles of commerce its products were not worth mentioning.

It was Mr. Kokichi Mikimoto, the proprietor of this firm, who first dreamed of how to increase this one natural produce of the numerous aquatic products of Japan.

At the Third National Industrial Exposition held in Tokio in 1890, Mr. Mikimoto exhibited some living specimens of pearl oysters from his native province of Shima, when the late Dr. Mitsukuri revealed to him the possibility of cultivating pearls. Mr. Mikimoto was greatly encouraged by this knowledge, and he put his heart and soul and all his fortune into the experiment. After repeated failures and many hardships, in the summer of

1894 he finally succeeded in producing pearls attached to the shells. He persisted in his efforts when finally in 1905, there appeared a gleam of hope in his research for the spherical pearl, and with further endeavor its perfection was attained at last.

Today scattered in different parts of Japan between the Bay of Gokasho and the Island of Palau in the south, he owns ten pearl farms, comprising an area of 50,000,000 tsubo, where 3,000,000 shells are planted each year. (Now 5,000,000.)

This leads us to the process of how this culture pearl is cultivated. The first requirement is that the pearl oyster be reared in the calm sea. The coast of Shima and Ise is the most ideal location for its cultivation.

The selection of oyster shells is also essential. Besides the oyster shells that are gathered from their natural ocean beds, the larvae which come floating about in summer are collected in wire cages painted with lime. Countless oyster spats are reared in the open sea for three years. Then a tiny shell bead, which forms the nucleus, is inserted in the flesh of each living oyster by means of a delicate operation. Here lies the chief difference between natural and culture pearl. In the case of the wild pearl, an irritant (miscellaneous foreign matter becoming the nucleus in the natural pearl), enters the oyster accidentally, while that of the culture pearl is placed there intentionally. There is no knowing what may enter the wild pearl. If such is the case, it may be said that culture pearl is more genuine in a way. After being so treated, the oysters are set free in the sea again for seven years. Then the culture pearl makes its first appearance in the kingdom of light. Amas (girl divers) have a vital part to perform in the cultivation and collection of pearls.

The most troublesome enemies encountered in this industry are the akashiwo (discolored current containing parasitic organism) and the cold current. When these sweep into the bay, the entire crop is destroyed. The octopus is also destructive. These have caused many a trying experience. In order to prevent the attack by dangerous creatures, the oyster shells which were formerly scattered in ocean beds are now kept in wire cages, suspended from tampo (rafts made of logs). When danger is foreseen, the cages may be removed to places free from the harmful current. There are 100 shells in each cage. Three times a year the shells in cages are hauled up to have the weeds and barnacles, hindering the development of the pearl, scraped off. These growths may even cost the life of the oysters.

It was after the great world war that the Mikimoto culture pearl made its appearance in the world market. When it was introduced to the market in London, it created an immense sensation among pearl dealers in London and Paris. "If a precious gem could be obtained by artificial means, it would result in the depreciation of the value of pearls. To what would that lead?" was the alarm raised by all the papers and periodicals. This aroused the fear of the jewelers and there followed a storm of protest, debarring culture pearls from the market. There is, however, a limit in the production of marketable pearls and it is virtually impossible to make them sprout so freely and abundantly as feared.

Leading biologists of England, the United States, France, Germany and Japan, after careful examination, claimed that culture pearls have all the qualifications and characteristics of genuine, natural pearls.

When the genuineness of culture pearls was hotly contested by the hostile group in France, the court at Paris decreed culture pearls to be real, genuine pearls in every sense of the word. Such recognition by eminent scientists and the court gave Mikimoto Pearl a name which stands very high on the scroll of fame and has not only made it one of the important products of the nation but of the world."